

REMARKS

File History

In the latest substantive Office action of 11/25/2005, and for the present application (*effective filing date: 11/19/2003*), the following allowances, rejections, objections, requirements and other actions appear to have been made:

- > Claim 27-33 were finally restricted out.
- > **Claims 1, 2, 11-16, 21-24, 34 and 37** were rejected under 35 USC §102(e) as being fully anticipated by Hui et al (US 6,514,868, issued 2/4/2003 and based on an application filed 3/26/2001).
- > **Claims 3-10, 35** were rejected under 35 USC §103(a) as being obvious over Hui et al as combined with Nishizawa (US 6,613,686 issued 9/2/2003 and based on an application published 6/28/01).
- > **Claims 17-20, 36** were rejected under 35 USC §103(a) as being obvious over Hui et al as combined with Chien (US Pub. 2002/0142610 of Oct. 3, 2002)
- > **Claims 25, 26** were rejected under 35 USC §103(a) as being obvious over Hui et al as combined with examiner reasoning.
- > **Claims 23-26** were rejected under 35 USC §112, paragraph 2 for being unclear.

Summary of Current Response

Claims 1 and 3 are amended.

Claims 27-33 are canceled without prejudice.

The specification is amended.

Arguments and evidence are presented concerning the amendment to the specification and concerning the applied art and its proposed combination.

Applicants' Overview of Outstanding Office Action

Applicant sees the outstanding Office action of 11/25/2005 as having the following major features (1)-(4):

(1) Overlooked in the action is the fact that the ARC layer is defined as being "organic" in originally filed Claims 3 and 34. (An electronic search through Hui 6,514,868 as stored on the PTO public database showed no instances of "organic".) At page 2 of the Office action (OA), the PTO admits that Hui's ARC is silicon nitride. Contrary to what is parenthetically implied by the PTO on page 2, silicon nitride (SiN) is not an organic material. A fairly accepted dictionary definition of "organic" is "of, relating to, or containing carbon compounds" -- Merriam-Webster Online Dictionary.

--{In the same breath Applicant concedes that an unintended error was made in paragraph [0045] of the present specification by wrongly citing SiN and SiON as examples and this error is rectified by the above amendment to paragraph [0045] of the specification and supported by a more detailed discussion below}--

(2) Overlooked in the action is the fact that Nishizawa defines SiN layer 5 as an etch stop for terminating etching with a fluorocarbon gas of an interlayer insulation (6) positioned above as shown in Fig. 1(b) (see also col. 1, lines 48-67). Nishizawa does not teach tapering of the SiN layer 5 in Figs. 1(c)-1(e) as it is etched through to expose the underlying copper (4).

(3) No objective evidence is provided to support the assertion that the recipe of Nishizawa would produce tapering. No objective evidence is provided of

motivation by an ordinary artisan to substitute the carbon-free Cl₂/HBr recipe of Hui with the non-tapering recipe shown by Nishizawa, and if it were done, the tapering effect would apparently disappear.

Instead, a conclusory assertion is made in rejecting Claim 3 for obviousness that:

It would have been obvious for one skilled in the art to etch the SiN [of Hui using the technique of, or] in light of Nishizawa because Hui teaches ... and Nishizawa further describe[s his technique as coming with] ... a reasonable expectation of success [for unspecified etch result].

(Office action, page 4, line 5-etc.; *underlining and bracketed text added.*)

(4) In rejecting Claims 17-20, 36, no motivation to combine is set forth for combining Nishizawa with Chien.

To Err is Human

Persons skilled in that art will readily recognize that Applicants made an obvious and thoughtless blunder by listing SiON, Si₃N₄, or mixtures of these as examples of organic compositions in paragraph [0045] of the specification. The rest of the specification is wholly inconsistent with this obviously inadvertent insertion. Most notably, see paragraph [0074] which refers to Si₃N₄ and SiON as hard masks that are "other kinds besides" organic ARC. As further support, note that original Claim 3 recites:

(a.1) said ARC layer is composed of an organic material;

(b.1) said photoresist layer is composed of an organic material;

[*Emphasis added.*]

Persons skilled in that art will readily recognize that Applicants clearly intended to convey that the ARC is a carbonaceous material of composition similar to that

commonly used in PR layers which are also generally carbonaceous materials, a main difference being that the organic ARC layers do not generally include photo-reactive materials in them while organic PR's typically do. It is stated in the very same paragraph [0045] immediately before the blunder that: "The ARC layer may be composed of any one of a variety of organic compounds that absorb light at wavelengths such as those used for imaging the overlying photoresist layer 280." [*Emphasis added.*] Moreover, it is explained in the paragraph that "The overlying photoresist layer 280 may be composed of a UV-sensitive photoresist material such as UV6". [*Emphasis added.*] Even Hui states that SiN is "reflective", thus it cannot be deemed equivalent to an absorptive organic ARC.

By way of external evidence showing that skilled artisans would understand that the error was unintentionally placed in original paragraph [0045], Applicant points to U.S. Patent 6,841,491 of Sadoughi, et al. issued January 11, 2005 (Title: In situ deposition of a nitride layer and of an anti-reflective layer) which includes the following passage:

A second approach for patterning a silicon nitride layer requires the use of an inorganic ARC (IARC) made of silicon oxy-nitride or silicon-rich silicon nitride instead of an organic ARC. An IARC yields better photolithography performance and is free from the stringer problem, because the IARC is more evenly deposited on the semiconductor substrate. Currently, the IARC is commonly deposited using plasma-enhanced chemical vapor deposition (PECVD). [*Emphasis added.*]

Skilled artisans would understand this passage to mean that SiON and SiN are used to make "inorganic" ARC or "IARC" where the latter is quite different from "organic" ARC.

Additionally, paragraph [0055] of the present specification explains:

Selective adhesion of such a carbonaceous coating to the exposed ARC surfaces 272' can help to minimize their erosion during the creation of vertical through-holes 231 in the ILD. More specifically, in one embodiment, the dielectric etch process 208 comprises the use of a 40 sccm flow of C4F6, ... The inclusion of the significant carbon monoxide content (e.g., 250 standard cubic centimeters per minute of CO) into the plasma

mix is believed to generate a carbonaceous coating material which preferentially adheres to the organic surface material of the ARC surfaces, including to corners 272b, but not so much to the inorganic material of the ILD material 230'. This preferential adherence is believed to cause the carbonaceous dielectric etch process 208 to be selective for vertical removal of the ILD material 230' as opposed to removal of the ARC material at bottom ARC corners 272b. As a result, much of the bottom corner material 272b of the taper-etched ARC layer (270 of Fig. 2B) is preserved and a substantial reduction in contact width size (235 as opposed to 285") is therefore realized. [*Emphasis added.*]

Skilled artisans will understand from this passage that the "organic" ARC layer is carbonaceous, which is why the generally alike "carbonaceous coating material ... preferentially adheres to the organic surface material of the ARC surfaces". In view of this, it is respectfully submitted that no new matter is being added to the specification by the above amendment to correct paragraph [0045] and that it will be clear to those skilled in the art that Applicants were in full written description possession of the understanding that the "organic" ARC layer is not composed of SiN or SiON; where mention of the latter was an inadvertent error that is inconsistent with overwhelming tenor of the rest of the specification (see again paragraph [0074]) and drawings (see Fig. 4).

Applicant's Reading of the Hui reference

Hui '868 forms the foundation of all art-based rejections and it is applied under 35 USC §102(e) given that Hui (pub'd 2/4/03) did not publish more than one year before the 11/19/03 filing date of the present application. Irrespective of the below detailed look at Hui, Applicant reserves the right to attack the use of Hui as a prior art reference under the legal fiction of 35 USC §102(e). 102(e) requires a §112 level of description. For example, Hui admits at col. 4, line 30 that the "exemplary" embodiments are preferred ones while not providing any details re recipes and so forth for the supposedly performed examples. Thus there is a question whether Hui satisfies all the requirements of 35 USC §112.

Assuming *arguendo* that Hui is applicable prior art, at col. 3, line 58, Hui teaches that ARC layer 26 (Fig. 2) should be a "reflective material" such as Si₃N₄ or SiON. (Note by contrast that the "organic" ARC of the present application is

described in paragraph [0045] as "composed of any one of a variety of organic compounds that absorb light at wavelengths such as those used for imaging the overlying photoresist layer" [*Emphasis added.*]

Additionally, in Fig. 3, Hui teaches that PR layer 22 (seen in Fig. 2) should be removed or stripped immediately after the tapered holes through the *inorganic* ARC have been formed (col. 4, line 3). By contrast, note Fig. 4 of the present application which advises that PR section 282 be retained in one embodiment so that the carbonaceous sidewall material 482a.3 can help protect taper corner 472a.3 as etching (431.3) proceeds with recipe 408 into the non-organic ILD layer 230'. See paragraph [0071] of the specification.

Additionally, Hui does not describe in any detail the formation of contact holes into ILD layer 14. Referring to Fig. 4 and col. 4, lines 18-28, Hui merely says that "The etch chemistry used to transfer the pattern from ARC layer 26 is any of a variety of etching techniques. In one embodiment, the etch chemistry used is a plasma etch technique. Advantageously, the transfer of the pattern from ARC layer 26 results in smaller critical dimensions for contact holes 18 (...FIG. 1)" [*Emphasis added.*] While it is true that Hui states at col. 3, lines 32-38 that "For example, contact holes 18 can be filled with tungsten (W) or silicides to contact with a gate conductor, a source region, or a drain region", it is speculation to decide the latter regions are part of an "active layers set" per Claim 2. (However this point is moot since Claim 1 is amended above.)

Hui compared against Claims rejected for Anticipation

Claim 1 is amended above and therefore discussion re Claim 1 and its dependencies versus the outstanding grounds of rejection for anticipation is moot.

Claims 34 and 37 are not amended however. Claim 34 recites: "(a) patterning an organic photoresist layer which is provided over an organic ARC layer ... (b) using an inwardly-tapering etch process to continue ... (c) using an anisotropic etch process to continue the inwardly-tapered through-holes ... as

substantially vertical contact holes through the dielectric layer; and (d) filling the substantially vertical contact holes with an electrical conductor." [*Emphasis added.*]

It is well established that anticipation requires each and every limitation to be expressly described in an enabling way in a single reference. Hui does not teach or suggest an "organic" ARC. Hui does not teach or suggest an etch method (b) for etching tapered holes into an "organic" ARC. Hui does not teach an "anisotropic" etch process (c) to continue the inwardly-tapered through-holes. Thus, a prima facie case for anticipation is not established.

Hui and Nishizawa compared against corresponding Claims (3-10) rejected for obviousness

The examiner is correct to find that Nishizawa discloses a SiN layer 5. This SiN layer 5 is not an "organic" ARC but rather an inorganic etch stop used in controlling termination of etching with a fluorocarbon gas through the interlayer insulation (6) shown in Fig. 1(b). (See also col. 1, lines 48-67). Nishizawa does not teach or suggest tapering of the SiN layer 5 in Figs. 1(c)-1(e) as it is etched through to expose the underlying copper (4). In fact, tapering the contact hole 8 to the copper line 4 would be disadvantageous because it would increase contact resistance and increase danger of open circuits if defects occur in the tapered metallization.

The PTO asserts that it would have been obvious to an ordinary artisan to combine Nishizawa with Hui and to substitute the etch recipe of Nishizawa (the one that creates a non-tapered hole through inorganic SiN (5) as shown in Fig. 1(c) of Nishizawa. The PTO speculates that the ordinary artisan would see a likelihood of success despite Nishizawa showing non-tapered holes and despite Nishizawa having an inverted situation where the ILD (6) is etched through first and the etch recipe of Nishizawa then being used to continue the hole through the underlying SiN (5) so as to reach the copper (4). No factual basis is provided for supporting these speculations. Besides, the proposed combination of Nishizawa with Hui fails

to recreate the currently claimed subject matter because neither of Hui and Nishizawa teaches or suggests an organic ARC layer.

Hui and Chien compared against corresponding Claims (17-20, 36) rejected for obviousness

Neither of Hui and Chien discloses an "organic" ARC, and so the correspondingly claimed subject matter cannot be logically recreated from their combination. Moreover, Chien lists long menus of materials from which the PTO picks and chooses using Applicant's disclosure as a template. This is hindsight. (Further, with regard to Claims 26-27, the OA at page 5 is clearly using hindsight by using Applicant's pages 7-8 as the basis of rejection.)

Indefiniteness Rejection (Claims 23-26)

Applicant understands that examiners can be overloaded with too much to read in too short a time. Please allow Applicant to briefly explain the language of Claim 23.

The specification explains in greater detail that the cost of making a photolithography mask is high. (See for example paragraph [0010] near its end.) The present technique allows a manufacturer to use just one mask and yet mass produce devices with different contact hole sizes. (See paragraph [0041].) This saves the manufacturer much in the way of time and money. The objected to language is directed to this aspect.

The mere fact that a given examiner may find it hard to read the language of a claim is not a valid basis for rejecting for indefiniteness. The latter rejection is supposed to be applied to persons of ordinary skill after having read the specification in detail. Applicant suspects the examiner will better understand

claims 23-26 in light of the above pointers to paragraphs [0010] and [0041].
Reconsideration is respectfully requested.

CONCLUSION

It is believed that all outstanding grounds of rejection have been overcome or traversed in light of the foregoing. Applicant respectfully requests entry of the amendments and reexamination with favorable outcome. Should any other action be contemplated by the Examiner, it is respectfully requested that he/she contact the undersigned at (408) 392-9250 to discuss the application.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 50-2257 for any matter in connection with this response, including any fee for extension of time and/or fee for additional claims, which may be required.

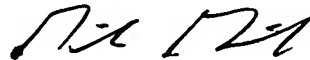
I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on February 27, 2006.

 2/24/06

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